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JOB COMPLETION REPORT
INVESTIGATIONS PROJECTS

..te of	Minnesota	Name	Migratory Waterfowl
Project No.	W-11-R-19	Title	Study of Incidence of Lead Shot in Certain Marshes and Lakes.
Job No.	10		

Period Covered: Office - Jan. - Dec. 1959
Field - June - Sept. 1959

ABSTRACT: A study was made of two important waterfowl lakes, Christina and Heron Lakes, for lead shot incidence in bottom soils during the summer of 1959. Samples of lake bottoms were taken by use of an Eckman dredge and washed through a fine seive to determine the density of shot in each lake. Both lakes were sub-sampled on the basis of hunting pressure.

Results indicated densities of about 1 shot per square foot in heavily hunted areas and 0.2 shot per square foot in moderately hunted areas of Christina Lake. Densities of shot in Heron Lake varied with individual areas of the lake from less than 0.1 shot per square foot to 0.7 per square foot. Recovery rates of shot increased with the depth of samples, indicating that in very soft-bottomed lakes shot may in time settle to depths greater than reached by feeding waterfowl.

A comparison of these data with those collected by Osmer in 1938-1939 on a portion of Heron Lake indicated a lead shot density approximately half that found by Osmer. This decrease in shot may not be real at all, but due to an increase in the depth of softer soils of Heron Lake during the past twenty years that has covered old accumulations of shot and permitted the settling of lead shot more recently discharged into the lake.

Previous investigations have shown that lead shot poisoning accounts for a significant loss of waterfowl annually. The availability of lead shot to waterfowl will vary on individual areas according to the hunting pressure and the nature of the underlying bottom soils.

OBJECTIVE: To determine trends in the accumulation of lead shot in certain marshes and lakes in Minnesota and its possible effects on waterfowl.

INTRODUCTION: Lead poisoning in waterfowl has been noted since the latter half of the nineteenth century. Since then, numerous investigations of its effects on waterfowl have been made by many investigators. Recently a compilation of these findings and their significance to waterfowl has been made by Bellrose (1959). According to data collected, Bellrose estimated that approximately 4 percent of the mallards in the Mississippi Flyway die in the wild as a result of lead poisoning and an additional 1 percent afflicted with lead poisoning are taken by hunters. This, we feel constitutes a significant loss that can be expected to increase in the future as increased hunting pressure adds to the accumulation of shot in lakes and marshes.

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For these reasons the present investigation was made to determine trends in the accumulation of lead shot in Minnesota lakes. Two lakes were sampled for lead shot incidence in the bottom soil during the summer of 1959. Christina Lake, Douglas and Grant Counties, a shallow lake of approximately 4,000 acres that has been a traditional stopping point for canvasbacks in Minnesota; and Heron Lake, Jackson County, another shallow lake with an area of approximately 8,000 acres, which also has a colorful history of waterfowl use and one on which lead shot incidence had been studied earlier by Osmer (1940).

TECHNIQUES: The published account of Osmer's work (Scientific Monthly, 1940), an unpublished supplemental paper, and the available field data of Osmer were studied to determine what was known in regards to lead shot distribution in Minnesota lakes as recorded by the earlier study of Osmer.

These data indicated that shot distribution would not be expected beyond a 300 yard range from shooting point, and, contrary to Osmer's assumption, that the shot distribution was not random. A preliminary field investigation was made on Boot Lake, Anoka County, using a Peterson dredge and an Eckman dredge. It was soon found that 1) a Peterson dredge could not be handled from a canoe, and 2) that collection and storage of samples for future examination in the laboratory would be very difficult because of weight and bulk.

Based on these findings it was decided that sampling of bottom soils would be made with the following assumptions: 1) Shot distribution in a lake can be sampled by stratified samples based on levels of hunting pressure. 2) Shot distribution within the lake is not random but rather in the nature of a contagious dispersion. 3) Shot distribution for a given strata of hunting pressure would be confined to an area within 300 yards of shooting sites (shoreline, and/or rushes).

The procedure followed was to delineate the points, passes, and other areas of heaviest hunting pressure as one strata to be sampled. Next a moderate hunting pressure zone was similarly delineated as the remaining shoreline and/or rushes.

Within each strata of hunting pressure sampling stations were set in a general way to equate area/station. These stations were then sampled by use of an Eckman dredge, the dredge being lowered to the bottom and then triggered by the release of a brass messenger. Samples thus obtained were washed and sifted at the site of collection by use of lake water and a No. 10 U. S. standard sieve (opening 0.0787 in.). It was found through repeated trials that shot could be washed through samples without loss and that they were readily identified amongst remaining debris.

Initially a hundred and sixty samples were taken in the heavily hunted portions of Christina Lake, (the points and passes). An analysis of the nature of shot distribution was then made as a guide to the number and distribution of further sampling stations necessary to describe the density of shot in the lake bottom. In general the number of sampling stations was set at a level so as

to detect the presence of shot at a density of one per ten square feet and to describe higher densities to within 0.3 shot per sq. ft. at the 95% confidence level.

FINDINGS: The results of bottom sampling of Christina Lake is given in Table 1 of the appendix and for Heron Lake in Table 2 of the appendix. The distribution of the sampling stations on Christina Lake is shown in Figure 1, and the distribution of sampling stations on Heron Lake are shown in Figures 2 and 3.

In examining the data collected on Christina Lake several interesting points were noted. A sub-sampling of zone A, heavily hunted area, into three groups indicated a similar recovery rate. Samples 1 thru 40, 41 thru 80, and 81 thru 160 indicated a shot density of 0.7, 1.1, and 1.15 per square foot respectively. This would substantiate the assumption that these areas had a similar hunting pattern. However, in samples taken in zone B, the moderately hunted area, a higher incidence in the extreme southwest bay, and in particular close to shore, would suggest that this area was subject to a higher hunting pressure than originally presumed. Indeed the presence of the road along this edge and the fact that it is a natural pass area to Pelican Lake located just to the west may well place it in the heavily hunted classification although it is here considered as a part of the moderately hunted portion.

Bottom types were not recorded at stations in Christina Lake, except on the moderately hunted portion. All stations in the moderately hunted portion were soft muck.

As samples were taken it became apparent to the crew on Heron Lake that the occurrence of shot varied with bottom firmness, a rather difficult thing to measure. A rule of thumb the crew used and which worked to some extent was, that if samples were firm enough to maintain a distinct shape in the sieve after being dropped in from the Eckman dredge - these samples yielded shot. Conversely, when samples dropped into the sieve from the Eckman dredge were so loose as to fill the sieve bottom with a liquid muck sealing off a flow of water through the sieve - these samples yielded no shot.

The survey crew, suspecting that shot were sifting to greater depths than the Eckman dredge was able to reach, borrowed a post-hole digger from a nearby farm. The crew took six auger samples along "Fighting Row" in the south portion of Heron Lake, an area that previously had yielded no shot when sampled with the Eckman dredge. These six auger samples encountered a sticky "yellowish" clay at a depth of about 6 inches and yielded 7 shot, three shot being taken in one sample, one sample with none, and the remainder having one shot each. This indicates a density of 5.9 shot per square foot, assuming the area sampled by the auger was equal to the auger area (28.4 sq. in.).

The high incidence of shot found by use of the post-hole digger suggested a very high density of shot at lower depths in the lake bed. To test this hypothesis further, an Eckman dredge mounted on a heavy pole was used in taking 75 samples in Heron Lake from three strategic areas. These were taken by pushing the dredge into the bottom soil. None of these samples, however, reached the yellowish

underlying clay. In South Heron Lake it penetrated deep enough to fill the dredge, while in North Heron Lake it penetrated only 4-5 inches. Table 3 of the appendix gives the results of the 75 samples taken by this latter method. Location of these samples is comparable to samples previously taken in the same respective areas by other methods.

The data as collected on both lakes and by various means (e.g. post-hole digger vs. Eckman dredge) were arranged by strata and then connected by the square root transformation. These transformed data were used to compute the confidence limits of each strata. The results of these analysis are given in Table 1.

Differences between means of samples obtained at various soil depths on the "Fighting Row" of South Heron Lake were tested by the "t" test. The "t" value for the difference between samples 1 and 2 was 3.24 with 25 degrees of freedom. This value is significant at the 95 percent level. For the difference between 2 and 3 the "t" value was 2.25 with 29 degrees of freedom. This value is also significant at the 95 percent level. It can be assumed then that the three different sampling methods were recovering shot at three distinct rates, depending on the depth of samples.

A similar test was made for samples obtained at various soil depths in Winzer Bay. The test yielded a "t" value of 0.419 with 58 degrees of freedom. Since this value is not significant at the 95 percent level, the rates of recovery for the two methods are apparently equal for this area. Redhead Bay also indicates a similar recovery rate for both methods.

These results indicate a vertical distribution of shot in bottom soils, the depth and rate of settling being primarily related to the soil firmness. Previous investigations by Wetmore and Bellrose, as reported by Bellrose, (op.cit.), have demonstrated this same type of distribution. Bellrose found the rate of shot settling was related to the shot size, the largest shot settling fastest. This rate is presumeably related to various forms of agitation (e.g. wave action, rough fish, etc.).

Observations indicate that most waterfowl, excepting divers, feed in the upper inch of bottom soil (Bellrose, op.cit.). It would appear then that a comparison of shot incidence from Osmer's work and the present investigation would indicate the relative availability of shot to waterfowl. Osmer took 23 Peterson dredge samples from the south and southeast sides of the north portion of Heron Lake with an average incidence of 2.00 shot per sq. ft. (Osmer, op. cit.). This same general area (samples 36 through 116) was sampled with 81 Eckman dredge samples for an average incidence of 0.74 shot per sq. ft., less than half that reported by Osmer, twenty years previous!

It's significant that Osmer reported the lake bottom as having been hard clay with one to three inches of mud over it. The Peterson dredge used by Osmer no doubt took some clay with such a thin layer of mud. The present investigation found over six inches of silt

Table 1. Comparison of Lead Shot Incidence and Confidence Limits for Christina and Heron Lakes by Sampling Strata.

Christina Lake

Location	Type of Sample	Shot/sq.ft.	95% Confidence Limit
Zone A (heavily hunted points and passes)	160 Eckman dredge samples	1.02	0.73 - 1.32
Zone B (moderately hunted shoreline and bulrushes)	162 Eckman dredge samples	0.22	0.13 - 0.31

Heron Lake

Location	Type of Sample	Shot/sq.ft.	95% Confidence Limit
"Fighting Row"-South portion			
	1. 20 Eckman dredge samples	0.00	Less than 0.10
	2. 25 Eckman dredge samples mounted on pole and pushed into ground	1.92	1.42 - 2.86
	3. 6 post-hole digger samples mounted on pole and pushed into ground	5.92	2.57 - 11.32
Remainder of South portion	80 Eckman dredge samples	0.10	Trace - 0.24
Redhead Bay - North portion			
	1. 20 Eckman dredge samples	0.00	Less than 0.10
	2. 25 Eckman dredge samples mounted on pole and pushed into ground	0.00	Less than 0.10
Winzer Bay - North portion			
	1. 35 Eckman dredge samples	0.34	0 - 0.73
	2. 25 Eckman dredge samples mounted on pole and pushed into ground	0.48	Trace - 1.01
East Bay - North portion	25 Eckman dredge samples	0.00	Less than 0.10
South shoreline of the North portion	81 Eckman dredge samples	0.74	0.27 - 1.21

and clay was not recovered in any samples with the Eckman dredge even when pushed into the bottom soil. Because most shot have settled through the soft silt until they are out of reach of the Eckman dredge, it could be presumed that such shot is also inaccessible to waterfowl.

A seasonal availability of shot (Bellrose, op.cit.) may account in part for the higher incidence rate found by Osmer as his samples were taken during the winter and those obtained during this study were taken during the summer, which allowed the previous season's shot pellets more time in which to settle deeper into the soil. This, however, is not believed to be significant as Osmer's samples were taken directly over the hard clay bottom (Osmer, op.cit).

SUMMARY AND CONCLUSIONS:

A study to determine the density of lead shot in the bottom soils of two Minnesota lakes was conducted during the summer of 1959. The lakes selected for study were Christina Lake, Douglas and Grant Counties, and Heron Lake, Jackson County, both important waterfowl areas.

The lakes were sub-sampled according to zones of hunting pressure, with each zone being sampled by means of an Eckman dredge. Samples thus obtained were washed through a No. 10 standard sieve in the field for lead shot.

The mean shot density in the heavily hunted portions of Christina Lake was 1.02 per sq. ft. with a 95 percent confidence limit of 0.73 per sq. ft. to 1.32 per sq. ft. The mean shot density in t moderately hunted portion of Christina Lake was 0.22 per sq. ft. with a 95 percent confidence limit of 0.13 per sq. ft. to 0.31 per sq. ft.

Lead shot densities in Heron Lake bottom soils varied according to the area sampled. In the south portion of Heron Lake the density of shot along "Fighting Row" was less than 0.10 per sq. ft., while the remainder of the south portion had a mean density of 0.10 per sq. ft. In the north portion of Heron Lake, Redhead Bay had less than 0.10 per sq. ft., East Bay had less than 0.10 per sq. ft., Winzer Bay had a mean density of 0.34 per sq. ft., and the south shoreline of the lake proper had a mean density of 0.74 per sq. ft.

A series of samples in Heron Lake were taken to establish whether or not the density of lead shot was related to the depth at which samples were taken. Such a relationship was established in the south portion of the lake, but none could be established in the north portion, presumeably because samples were never taken at a sufficient bottom soil depth to reach shot pellets which had settled into the soft bottom.

Comparison of data collected on the north portion of Heron Lake by Osmer in 1939-40 indicates that the present shot density is approximately half the density as found at the date of his study. The reason for this lower recovery rate is felt to be due to the filling in of the lake bed with fine silt particles which have allowed s pellets to settle to a depth beyond that sampled with the Eckman dredge.

The lower density of shot found during this study reflects a correspondingly lower availability of shot to feeding waterfowl.

On the basis of information gathered during this study, it would appear that lead shot availability to waterfowl on an individual area will be closely related to hunting pressure and nature of the underlying soils. It is therefore believed that many areas will pose less of a problem in the future as siltation covers existing shot and allows others a soft bottom through which they may settle, while other areas with firm bottom soils will accumulate higher concentrations of shot and conceivably become untenable by waterfowl at some future date.

The problem of lead shot poisoning will have to be evaluated on the basis of individual areas.

RECOMMENDATIONS:

1. Future sampling of lead shot incidence in bottom soils should be made to provide a statistical base for evaluation of changing availability to waterfowl.

2. It's recommended a study be undertaken to determine the density of lead shot in bottom soils as related to its ingestion rate by waterfowl. Such a study would provide a basis for determining the "safe" and "untenable" levels of shot in bottom soils of waterfowl lakes and marshes.

3. Although the data presented here indicates less availability of shot to waterfowl now than twenty years previous, it is felt that it still accounts for a significant and unnecessary loss of waterfowl. Data collected on these two lakes suggest that other areas with firm bottoms become progressingly less tenable by waterfowl as shot densities accumulate. It's therefore recommended that consideration by given to the adoption of non-toxic iron alloy shot in hunting waterfowl.

LITERATURE CITED:

Bellrose, Frank C.
1959. Lead Poisoning as a Mortality Factor in Waterfowl Populations. Illinois Natural History Survey Bulletin. Volume 27, Article 3.

Osmer, Thos. L. G.
1940. Lead Shot: Its Danger to Waterfowl. The Scientific Monthly. Volume L:455-459.

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"This portion of the study conducted by Project FW-1-R (P-R)."

FIGURE 1
LOCATION OF ECKMAN DREDGE SAMPLES
LEAD SHOT STUDY 1959

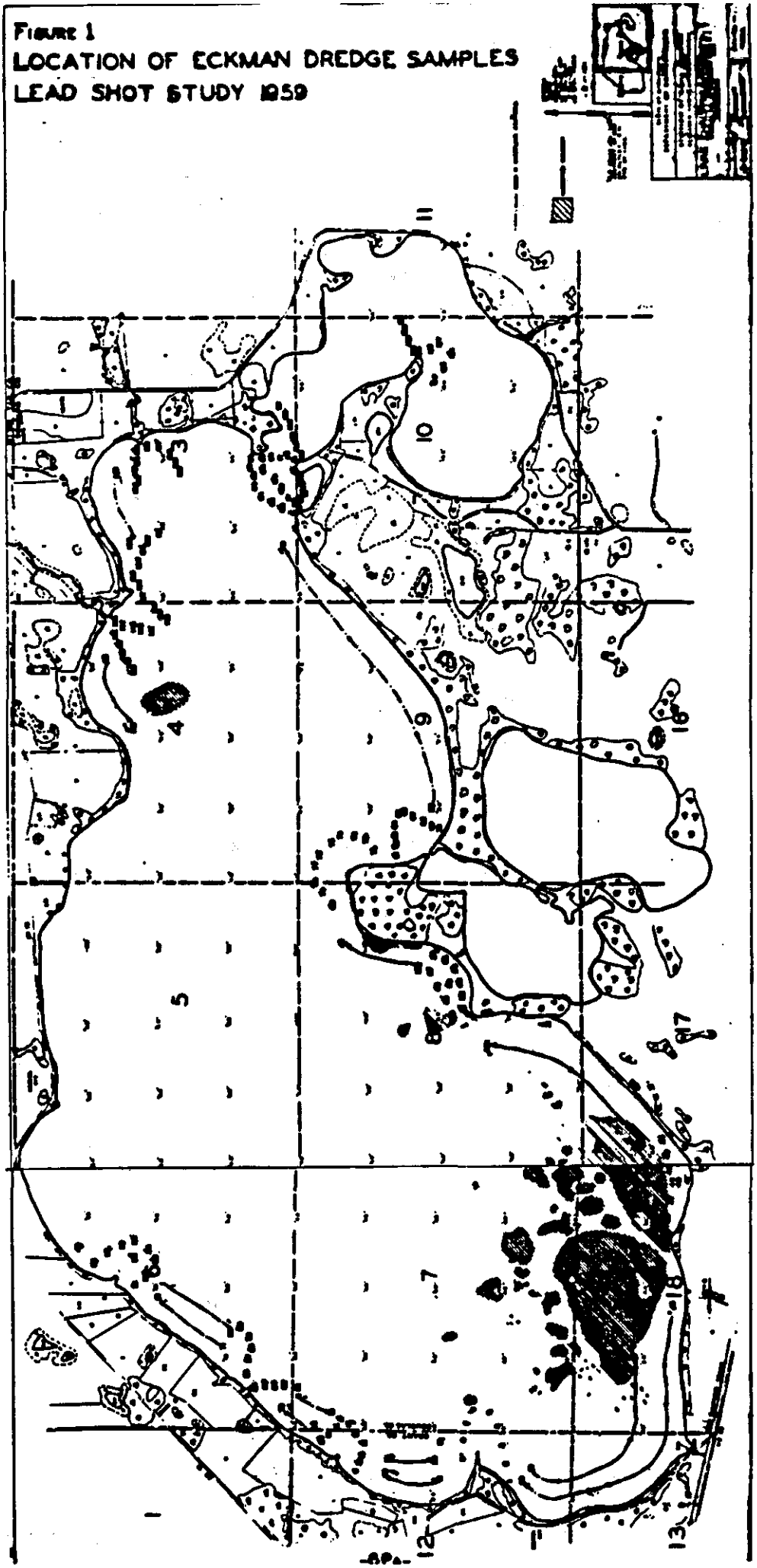


FIGURE 2 – LOCATION OF ECKMAN DREDGE SAMPLES LEAD SHOT STUDY 1959

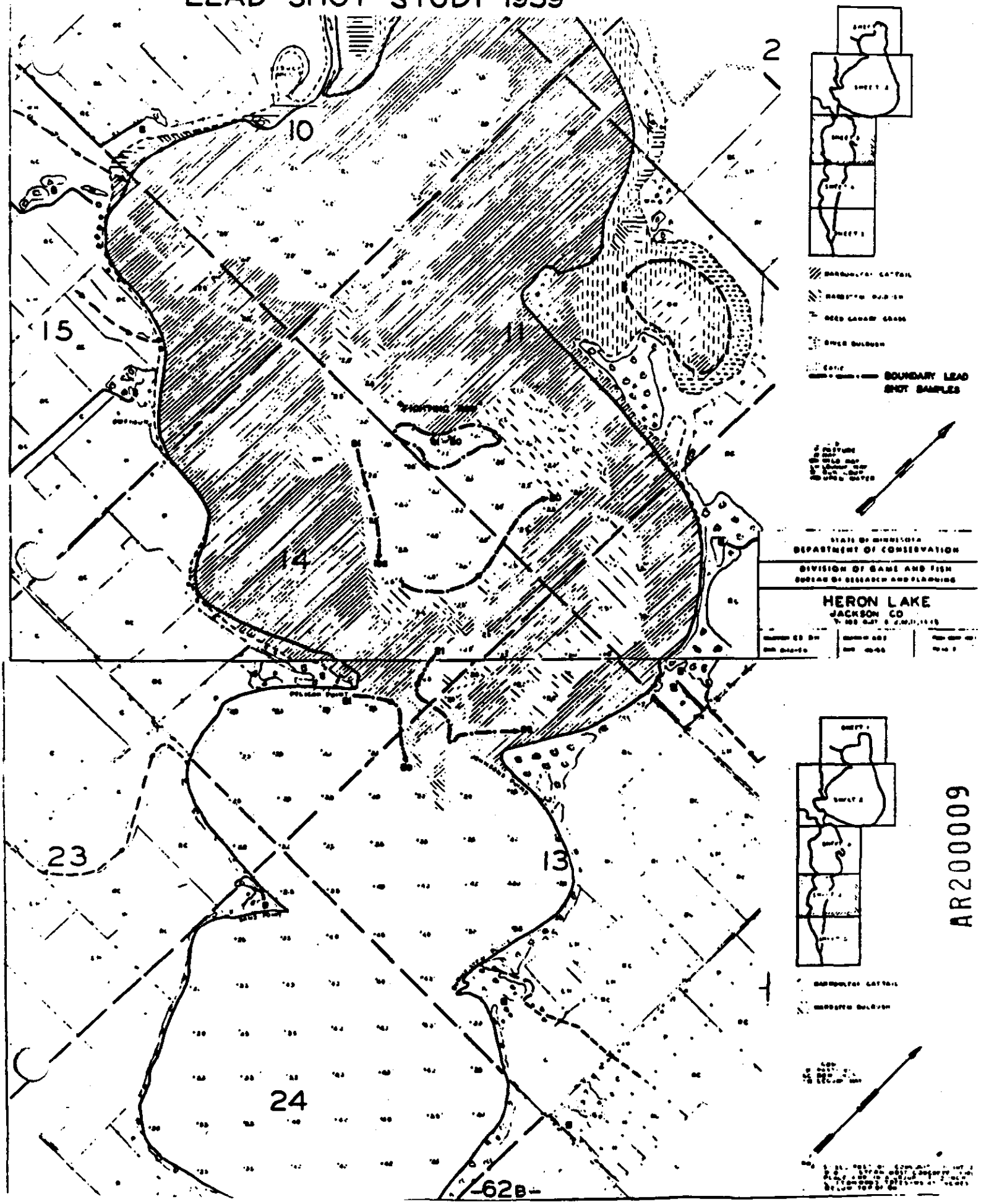
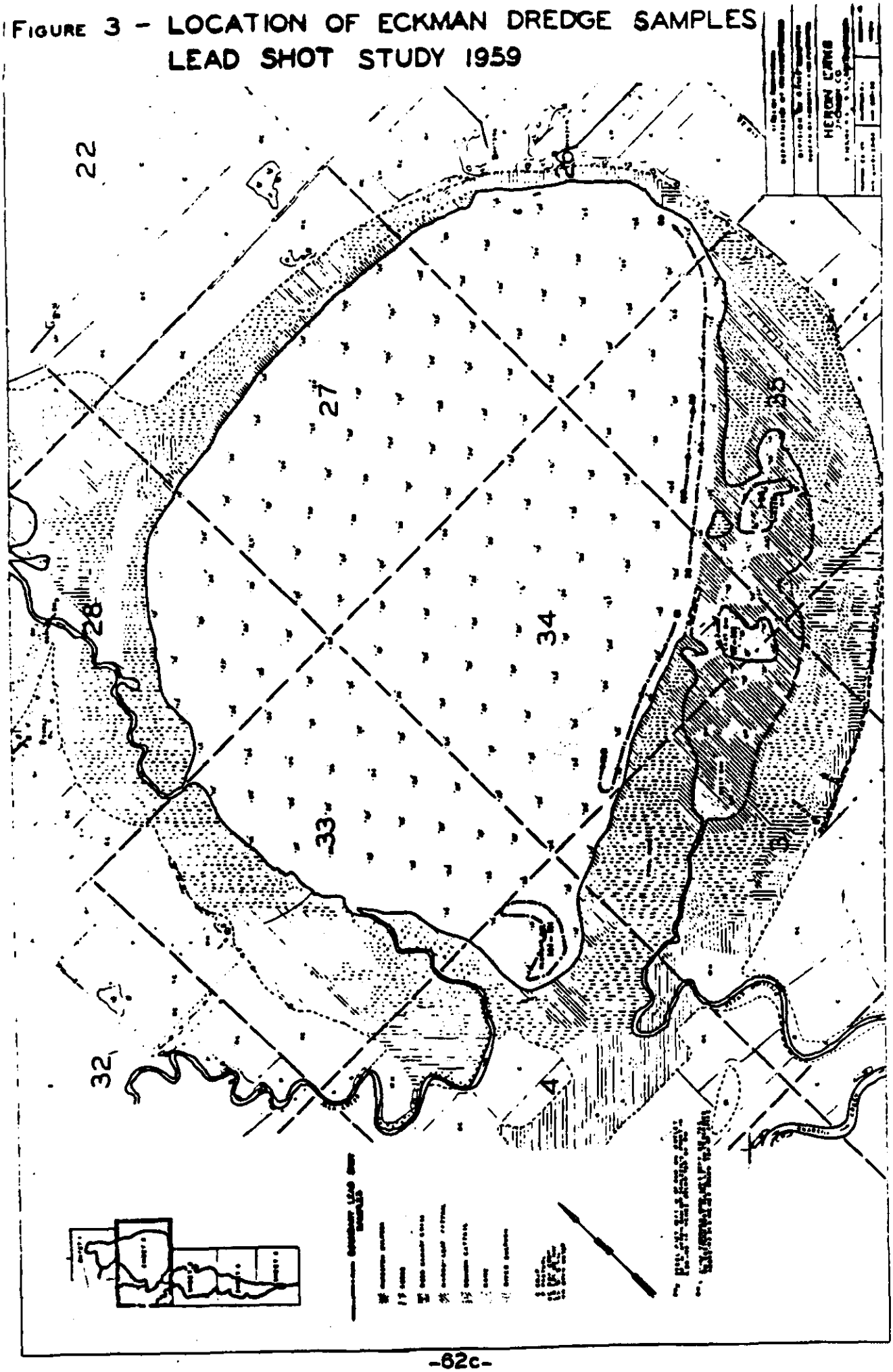


FIGURE 3 - LOCATION OF ECKMAN DREDGE SAMPLES
LEAD SHOT STUDY 1959



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Appendix Table 1. Lead Shot Incidence in Christina Lake as Determined by Use of an Eckman Dredge.*

Zone A - Heavily Hunted Area

Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered
1.	0	41.	0	81.	0	121.	0
2.	0	42.	0	82.	0	122.	0
3.	0	43.	0	83.	0	123.	0
4.	0	44.	0	84.	0	124.	0
5.	1	45.	0	85.	0	125.	0
6.	1	46.	0	86.	1	126.	0
7.	1	47.	0	87.	0	127.	0
8.	0	48.	0	88.	2	128.	0
9.	0	49.	0	89.	6	129.	0
10.	0	50.	0	90.	0	130.	0
11.	0	51.	0	91.	0	131.	0
12.	0	52.	2	92.	0	132.	0
13.	0	53.	1	93.	0	133.	1
14.	0	54.	0	94.	0	134.	1
15.	0	55.	0	95.	0	135.	0
16.	0	56.	1	96.	0	136.	0
17.	0	57.	1	97.	0	137.	0
18.	0	58.	1	98.	0	138.	0
19.	0	59.	1	99.	0	139.	0
20.	0	60.	0	100.	0	140.	0
21.	0	61.	0	101.	0	141.	0
22.	0	62.	1	102.	0	142.	0
23.	1	63.	0	103.	2	143.	0
24.	0	64.	0	104.	2	144.	0
25.	0	65.	0	105.	0	145.	0
26.	0	66.	0	106.	0	146.	0
27.	0	67.	0	107.	0	147.	0
28.	0	68.	1	108.	1	148.	0
29.	0	69.	0	109.	0	149.	0
30.	1	70.	0	110.	0	150.	0
31.	0	71.	0	111.	0	151.	0
32.	0	72.	0	112.	0	152.	4
33.	0	73.	1	113.	0	153.	1
34.	0	74.	0	114.	0	154.	0
35.	1	75.	0	115.	0	155.	1
36.	0	76.	0	116.	0	156.	0
37.	1	77.	0	117.	1	157.	0
38.	0	78.	0	118.	0	158.	0
39.	0	79.	1	119.	0	159.	0
40.	0	80.	0	120.	0	160.	0

* Bottom types were not recorded for Christina Lake except on the moderately hunted portion, which was all soft muck.

Appendix Table 1. (cont.)

Zone B - Moderately Hunted Area

Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered	Sample Number	No. Shots Recovered
1.	0	41.	0	81.	0	122.	0
2.	0	42.	0	82.	0	123.	0
3.	0	43.	0	83.	0	124.	0
4.	0	44.	0	84.	0	125.	0
5.	0	45.	0	85.	0	126.	0
6.	0	46.	0	86.	0	127.	1
7.	0	47.	0	87.	0	128.	0
8.	0	48.	1	88.	0	129.	0
9.	0	49.	0	89.	0	130.	0
10.	0	50.	1	90.	0	131.	0
11.	0	51.	0	91.	0	132.	0
12.	0	52.	0	92.	0	133.	0
13.	0	53.	0	93.	0	134.	0
14.	0	54.	1	94.	0	135.	0
15.	0	55.	0	95.	1	136.	0
16.	0	56.	1	96.	0	137.	0
17.	0	57.	0	97.	0	138.	0
18.	0	58.	0	98.	0	139.	0
19.	0	59.	0	99.	0	140.	0
20.	0	60.	0	100.	0	141.	0
21.	0	61.	0	101.	0	142.	0
22.	0	62.	0	102.	1	143.	0
23.	0	63.	0	103.	1	144.	0
24.	0	64.	0	104.	0	145.	0
25.	0	65.	0	105.	0	146.	0
26.	0	66.	0	106.	0	147.	0
27.	0	67.	0	107.	0	148.	0
28.	0	68.	0	108.	0	149.	0
29.	0	69.	0	109.	0	150.	0
30.	0	70.	0	110.	0	151.	0
31.	0	71.	0	111.	0	152.	0
32.	0	72.	0	112.	0	153.	0
33.	0	73.	0	113.	0	154.	0
34.	0	74.	0	114.	0	155.	0
35.	1	75.	0	115.	0	156.	0
36.	0	76.	0	116.	0	157.	0
37.	0	77.	0	117.	0	158.	0
38.	0	78.	0	118.	0	159.	0
39.	0	79.	0	119.	0	160.	0
40.	0	80.	0	120.	0	161.	0
				121.	0	162.	0

Appendix Table 2. Lead Shot Incidence in Heron Lake as Determined by Use of an Eckman Dredge.

South Portion

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
1.	Muck	0	22.	Sandy Loam	0
2.	Muck	0	23.	Sandy Loam	0
3.	Muck	0	24.	Sandy Loam	0
4.	Muck	0	25.	Sandy Loam	0
5.	Muck	0	26.	Sandy Loam	0
6.	Muck	0	27.	Sandy Loam	0
7.	Muck	0	28.	Sandy Loam	0
8.	Muck	0	29.	Sandy Loam	0
9.	Muck	0	30.	Sandy Loam	0
10.	Muck	0	31.	Sandy Loam	0
11.	Muck	0	32.	Muck	0
12.	Muck	0	33.	Muck	0
13.	Muck	0	34.	Muck & Gravel	0
14.	Muck	0	35.	Muck & Gravel	0
15.	Muck	0	36.	Muck & Gravel	0
16.	Muck	0	37.	Muck & Gravel	0
17.	Muck	0	38.	Muck & Gravel	0
18.	Muck	0	39.	Muck & Gravel	0
19.	Muck	0	40.	Muck & Gravel	0
20.	Muck	0	41.	Muck	0
21.	Sandy Loam	0	42.	Muck	0

[redacted]

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
43.	Muck	0	72.	Muck	0
44.	Muck	0	73.	Muck	0
45.	Muck	0	74.	Muck	0
46.	Muck	0	75.	Muck	0
47.	Muck	0	76.	Muck	0
48.	Muck	0	77.	Muck	0
49.	Muck	0	78.	Muck	0
50.	Muck	0	79.	Muck	0
51.	Sand	0	80.	Muck	0
52.	Sand	0	81.	Sandy Muck	0
53.	Sand	0	82.	Sandy Muck	0
54.	Sand	0	83.	Sandy Muck	0
55.	Sand	0	84.	Sandy Muck	0
56.	Sand	1	85.	Sandy Muck	0
57.	Sand	0	86.	Sandy Muck	1
58.	Sand	0	87.	Sandy Muck	0
59.	Sand	0	88.	Sandy Muck	0
60.	Sand	0	89.	Sandy Muck	0
61.	Muck	0	90.	Sandy Muck	0
62.	Muck	0	91.	Sandy Muck	0
63.	Muck	0	92.	Muck	0
64.	Muck	0	93.	Muck	0
65.	Muck	0	94.	Muck	0

(Table 2. Cont.)

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
66.	Muck	0	95.	Muck	0
67.	Muck	0	96.	Muck	0
68.	Muck	0	97.	Muck	0
69.	Muck	0	98.	Muck	0
70.	Muck	0	99.	Muck	0
71.	Muck	0	100.	Muck	0

North Portion

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
1.	Silty Muck	1	23.	Silty Muck	0
2.	Silty Muck	0	24.	Silty Muck	0
3.	Silty Muck	0	25.	Silty Muck	0
4.	Silty Muck	0	26.	Silty Muck	0
5.	Silty Muck	0	27.	Silty Muck	0
6.	Silty Muck	0	28.	Silty Muck	0
7.	Silty Muck	0	29.	Silty Muck	0
8.	Silty Muck	0	30.	Silty Muck	0
9.	Silty Muck	0	31.	Silty Muck	0
10.	Silty Muck	0	32.	Silty Muck	0
11.	Silty Muck	1	33.	Silty Muck	0
12.	Silty Muck	0	34.	Silty Muck	0
13.	Silty Muck	0	35.	Silty Muck	0
14.	Silty Muck	0	36.	Sandy Silt	0
15.	Silty Muck	0	37.	Sandy Silt	0
16.	Silty Muck	0	38.	Sandy Silt	0
17.	Silty Muck	0	39.	Sandy Silt	0
18.	Silty Muck	1	40.	Sandy Silt	0
19.	Silty Muck	0	41.	Sandy Silt	0
20.	Silty Muck	0	42.	Sandy Silt	1
21.	Silty Muck	0	43.	Sandy Silt	0
22.	Silty Muck	0	44.	Sandy Silt	0

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
45.	Sandy Silt	0	102.	Coarse Silt	0
46.	Fine Silt	0	103.	Coarse Silt	1
47.	Fine Silt	0	104.	Coarse Silt	2
48.	Fine Silt	0	105.	Coarse Silt	0
49.	Fine Silt	0	106.	Coarse Silt	0
50.	Coarse Silt	0	107.	Coarse Silt	0
51.	Coarse Silt	0	108.	Coarse Silt	0
52.	Coarse Silt	0	109.	Coarse Silt	0
53.	Coarse Silt	0	110.	Coarse Silt	0
54.	Coarse Silt	0	111.	Coarse Silt	0
55.	Coarse Silt	0	112.	Coarse Silt	0
56.	Coarse Silt	1	113.	Coarse Silt	0

(Table 2. cont.)

Sample No.	Bottom Type	No. Shot Recovered	Sample No.	Bottom Type	No. Shot Recovered
57.	Coarse Silt	1	114.	Coarse Silt	0
58.	Coarse Silt	3	115.	Coarse Silt	0
59.	Coarse Silt	0	116.	Coarse Silt	1
60.	Coarse Silt	1	117.	Silt Muck	0
61.	Coarse Silt	0	118.	Silt Muck	0
62.	Coarse Silt	0	119.	Silt Muck	0
63.	Coarse Silt	0	120.	Silt Muck	0
64.	Coarse Silt	1	121.	Silt Muck	0
65.	Coarse Silt	0	122.	Silt Muck	0
66.	Coarse Silt	0	123.	Silt Muck	0
67.	Coarse Silt	0	124.	Silt Muck	0
68.	Coarse Silt	0	125.	Silt Muck	0
69.	Coarse Silt	0	126.	Silt Muck	0
70.	Coarse Silt	0	127.	Silt Muck	0
71.	Coarse Silt	0	128.	Silt Muck	0
72.	Coarse Silt	0	129.	Silt Muck	0
73.	Coarse Silt	0	130.	Silt Muck	0
74.	Coarse Silt	0	131.	Silt Muck	0
75.	Coarse Silt	0	132.	Silt Muck	0
76.	Coarse Silt	0	133.	Silt Muck	0
77.	Coarse Silt	0	134.	Silt Muck	0
78.	Coarse Silt	0	135.	Silt Muck	0
79.	Coarse Silt	0	136.	Silt Muck	0
80.	Coarse Silt	0	137.	Silt Muck	0
81.	Coarse Silt	0	138.	Silt Muck	0
82.	Coarse Silt	0	139.	Silt Muck	0
83.	Coarse Silt	0	140.	Silt Muck	0
84.	Coarse Silt	0	141.	Muck	0
85.	Coarse Silt	0	142.	Muck	0
86.	Coarse Silt	0	143.	Muck	0
87.	Coarse Silt	0	144.	Muck	0
88.	Coarse Silt	0	145.	Muck	0
89.	Coarse Silt	0	146.	Muck	0
90.	Coarse Silt	1	147.	Muck	0
91.	Coarse Silt	0	148.	Muck	0
92.	Coarse Silt	0	149.	Muck	0
93.	Coarse Silt	0	150.	Muck	0
94.	Coarse Silt	0	151.	Muck	0
95.	Coarse Silt	0	152.	Muck	0
96.	Coarse Silt	0	153.	Muck	0
97.	Coarse Silt	0	154.	Muck	0
98.	Coarse Silt	0	155.	Muck	0
99.	Coarse Silt	0	156.	Muck	0
100.	Coarse Silt	0	157.	Muck	0
101.	Coarse Silt	0	158.	Muck	0

Sample No.	Bottom Type	No. Shot Recovered
159.	Muck	0
160.	Muck	0
161.	Muck	0

Appendix Table 3. Lead Shot Incidence in Bottom Soils of Heron Lake as Indicated by Use of an Eckman Dredge Pushed into Bottom Soil.

Sample No. & Location	No. Shot Recovered	Sample No. & Location	No. Shot Recovered
1A. Fighting row - South portion	2	28A. Redhead Bay - North portion	0
2A. Fighting row - South portion	0	29A. Redhead Bay - North portion	0
3A. Fighting row - South portion	0	30A. Redhead Bay - North portion	0
4A. Fighting row - South portion	1	31A. Redhead Bay - North portion	0
5A. Fighting row - South portion	0	32A. Redhead Bay - North portion	0
6A. Fighting row - South portion	0	33A. Redhead Bay - North portion	0
7A. Fighting row - South portion	2	34A. Redhead Bay - North portion	0
8A. Fighting row - South portion	1	35A. Redhead Bay - North portion	0
9A. Fighting row - South portion	0	36A. Redhead Bay - North portion	0
10A. Fighting row - South portion	0	37A. Redhead Bay - North portion	0
11A. Fighting row - South portion	0	38A. Redhead Bay - North portion	0
12A. Fighting row - South portion	1	39A. Redhead Bay - North portion	0
13A. Fighting row - South portion	1	40A. Redhead Bay - North portion	0
14A. Fighting row - South portion	0	41A. Redhead Bay - North portion	0
15A. Fighting row - South portion	0	42A. Redhead Bay - North portion	0
16A. Fighting row - South portion	0	43A. Redhead Bay - North portion	0
17A. Fighting row - South portion	3	44A. Redhead Bay - North portion	0
18A. Fighting row - South portion	0	45A. Redhead Bay - North portion	0
19A. Fighting row - South portion	0	46A. Redhead Bay - North portion	0
20A. Fighting row - South portion	0	47A. Redhead Bay - North portion	0
21A. Fighting row - South portion	0	48A. Redhead Bay - North portion	0
22A. Fighting row - South portion	0	49A. Redhead Bay - North portion	0
23A. Fighting row - South portion	0	50A. Redhead Bay - North portion	0
24A. Fighting row - South portion	0	51A. Winzer Bay - North portion	0
25A. Fighting row - South portion	1	52A. Winzer Bay - North portion	0
26A. Redhead Bay - North portion	0	53A. Winzer Bay - North portion	0
27A. Redhead Bay - North portion	0	54A. Winzer Bay - North portion	0

(Table 3 cont.)

Sample No. & Location		No. Shot Recovered	Sample No. & Location		No. Shot Recovered
55A.	Winzer Bay - North portion	0	66A.	Winzer Bay - North portion	1
56A.	Winzer Bay - North portion	0	67A.	Winzer Bay - North portion	0
57A.	Winzer Bay - North portion	0	68A.	Winzer Bay - North portion	0
58A.	Winzer Bay - North portion	0	69A.	Winzer Bay - North portion	0
59A.	Winzer Bay - North portion	0	70A.	Winzer Bay - North portion	0
60A.	Winzer Bay - North portion	0	71A.	Winzer Bay - North portion	0
61A.	Winzer Bay - North portion	0	72A.	Winzer Bay - North portion	2
62A.	Winzer Bay - North portion	0	73A.	Winzer Bay - North portion	0
63A.	Winzer Bay - North portion	0	74A.	Winzer Bay - North portion	0
64A.	Winzer Bay - North portion	0	75A.	Winzer Bay - North portion	0
65A.	Winzer Bay - North portion				